

**REMARKS**

Claims 1-20 were examined and reported in the Office Action. Claims 1-20 are rejected. In the instant response, Claims 1, 2, 3, 7, 8, 9 and 16 are amended. Claim 7 is cancelled and no claims are added. Claims 1-6 and 8-20 are pending. Applicant requests reconsideration of the application in view of the following amendments and remarks.

The instant application is directed to a method for forming a device isolation layer of a semiconductor device, comprising the steps of, forming a pad layer pattern defining a device isolation layer on a substrate, forming a trench by etching an exposed portion of the substrate with use of the pad layer pattern as a mask, performing an etching process to make top corners of the trench rounded by controlling an angle of the top corners of the trench according to a contained quantity of hydrogen bromide and chlorine gas in an etching gas, forming a lateral oxide layer on a partial surface of the substrate, the partial surface consisting of sidewalls and a bottom area in the trench by a dry oxidation technique, wherein the dry oxidation technique oxidates the sidewalls and bottom area in the trench formed by the etching process, forming a liner nitride layer on the lateral oxide layer, forming an insulation layer on the liner nitride layer to fill the trench; and planarizing the insulation layer.

**I. Claim Amendments**

In the instant response, Claims 1, 2, 3, 8, 9 and 16 are amended to particularly point out and distinctly claim the subject matter of the present invention without adding any new matter. In particular, independent Claim 1 is amended to clarify that the etching process to make top corners of the trench rounded involves controlling an angle of the top corners of the trench according to a contained quantity of hydrogen bromide and chlorine gas in an etching gas and forming a lateral oxide layer on a partial surface of the substrate, the partial surface consisting of sidewalls and a bottom area in the trench by a dry oxidation technique, wherein the dry oxidation technique oxidates the sidewalls and bottom area in the trench formed by the etching process. Support for the amendments to Claim 1 may be found for example on page 11, lines 14 to page 13, line 5; page 13, lines 6-20; Figure 2D; original Claim 2.

Claim 8 is amended to depend from Claim 1 instead of now cancelled Claim 7.

Claim 9 is amended to clarify that forming a trench of which top corners are rounded by etching a surface of a substrate to a predetermined depth by controlling an angle of the top corners of the trench according to a contained quantity of hydrogen bromide and chlorine gas in an etching gas and forming a lateral oxide layer on a partial surface of the substrate, the partial surface consisting of sidewalls and a bottom area of the trench by oxidizing sidewalls of the trench and the bottom area in the trench formed by the etching process. Support for the amendments to Claim 9 may be found for example on page 11, lines 14 to page 13, line 5; page 13, lines 6-20; Figure 2D.

Claims 2 and 16 are amended to delete the recitation of forming the trench by controlling an angle through the use of a gas containing at least hydrogen bromide and chlorine gas to avoid redundancy with amended Claims 1 and 9 respectively. Thus, the amendment is supported by the specification and does not add new matter.

Claim 3 is amended to clarify that the steps recited in Claim 3 are included in the step of performing the etching process. Support for the amendment may be found, for example, on page 11, line 14 to page 12, line 10.

In view of the foregoing, Applicant respectfully submits the amendments are supported by the specification and do not add new matter. Applicant respectfully requests consideration and entry of the amendments to Claims 1, 2, 3, 9 and 16.

**I. Claim Rejections – 35 U.S.C. §103(a)**

**A.** The Examiner rejects Claim 1 under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent 6,225,187 issued to Huang et al (“Huang”), and U. S. Patent 4,571,819 issued to Rogers et al (“Rogers”). Applicant respectfully traverses the rejection for at least the following reasons.

To render a claim obvious, the relied upon references must disclose every limitation of the claim such that the invention as a whole would have been obvious at the time the invention was made to one skilled in the art. MPEP §2143. Furthermore, there must be a showing of

suggestion or motivation to modify or combine the teachings of those references. *In re Rouffet*, 149 F.3d 1350, 1357, 47 USPQ2d 1453, 1457-58 (Fed. Cir. 1998).

In the outstanding Action, the Examiner alleges Huang teaches controlling an angle of the top corners of the trench though the use of gas containing at least hydrogen bromide and chlorine gas (col. 2, line 15) however admits Huang fails to teach the elements of forming a lateral oxide layer by oxidizing sidewalls of the trench formed after the etching process, forming a nitride layer on the lateral oxide layer, forming an insulation layer on the liner nitride layer to fill the trench and planarizing the insulation layer. See Action, page 5. The Examiner instead relies upon Rogers to teach these elements alleging it would have been obvious to one skilled in the art to incorporate these features of Rogers into that of Huang to arrive at Applicant's invention. See Action, page 5.

Applicant respectfully disagrees with the Examiner's conclusions and submits the references fail to teach or suggest at least the elements of performing an etching process to make top corners of the trench rounded by controlling an angle of the top corners of the trench according to a contained quantity of hydrogen bromide and chlorine gas in an etching gas and forming a lateral oxide layer on a partial surface of the substrate, the partial surface consisting of sidewalls and a bottom area in the trench by a dry oxidation technique, wherein the dry oxidation technique oxidizes the sidewalls and bottom area in the trench formed by the etching process as recited in amended Claim 1.

Huang teaches that removal of the exposed hard mask layer 220 and underlying oxide layer 210 within opening 240 with an etching gas consisting of a mixture of CHF<sub>3</sub>/CF<sub>4</sub>/O<sub>2</sub>/Ar or mixture consisting of SF<sub>6</sub>/CHF<sub>3</sub> creates rounded corner 245. See Huang, Figures 2B, 2C and col. 3, lines 7-26. The step cited by the Examiner in col. 2, line 15 of Huang is subsequent to formation of the rounded corner. In particular Huang teaches the mixture of hydrogen bromide and chlorine gas is used to remove the substrate 200 within window 240 and that because corner 245 of the window is already rounded, the corner of the trench is also rounded. See Huang, col. 3, lines 20-26; Figures 2B, 2C. Thus it is the first etching step using a mixture of CHF<sub>3</sub>/CF<sub>4</sub>/O<sub>2</sub>/Ar or mixture consisting of SF<sub>6</sub>/CHF<sub>3</sub> that is used to form the rounded corner, not

a mixture of hydrogen bromide and chlorine. Thus, Huang does not teach an etching process to make top corners of the trench rounded by controlling an angle of the top corners of the trench according to a contained quantity of hydrogen bromide and chlorine gas in an etching gas as required by Claim 1.

Moreover, the lateral oxide layer 16 shown in Figure 7 of Rogers may not be relied upon to teach the element of forming a lateral oxide layer on a partial surface of the substrate, the partial surface consisting of sidewalls and a bottom area in the trench by a dry oxidation technique, wherein the dry oxidation technique oxidates the sidewalls and bottom area in the trench formed by the etching process as further recited in Claim 1. In Rogers, the lateral oxide layer 16 is formed to a thickness of about 300 to 400 by a thermal oxidation or a chemical vapor oxidation. See Rogers, column 5: lines 25 to 30 and Fig. 3. Moreover, the lateral oxide layer 16 is formed on the whole surface after forming a trench, i.e., not a partial surface including only sidewalls and a bottom area of a trench but also top surfaces of the substrate 10. On the contrary, in the claimed invention, the lateral oxide layer is formed by a dry oxidation technique by oxidating a partial surface of the substrate consisting of sidewalls and a bottom area of the trench. Thus, for at least the foregoing reasons, neither Huang nor Rogers, alone or in combination, teach or suggest each and every element of Claim 1. In view of the foregoing, a prima facie case of obviousness may not be established. Applicant respectfully requests reconsideration and withdrawal of the rejection of Claim 1 under 35 U.S.C. §103.

**B.** The Examiner rejects Claims 2-8 under 35 U.S.C. 103(a) as being unpatentable over Huang and Rogers as applied to claim 1 above, and further in view of U. S. Patent 6,180,466 issued to Ibok. Applicant respectfully traverses the rejection for at least the following reasons.

Claims 2-7, Claim 7 is cancelled, Claims 2-6 depend from Claim 1 and incorporate the limitations thereof. Thus, for at least the reasons previously discussed in regard to Claim 1, Huang and Rogers fail to teach or suggest at least the elements of performing an etching process to make top corners of the trench rounded by controlling an angle of the top corners of the trench according to a contained quantity of hydrogen bromide and chlorine gas in an etching gas and forming a lateral oxide layer on a partial surface of the substrate, the partial surface consisting of

sidewalls and a bottom area in the trench by a dry oxidation technique, wherein the dry oxidation technique oxidates the sidewalls and bottom area in the trench formed by the etching process as founded in Claims 2-6. The Examiner has not pointed to a portion of Ibok curing the deficiencies of Huang and Rogers with respect to these elements.

The Examiner alleges Ibok teaches controlling an angle of the top corners of the trench in a range from about 30 degrees to about 60 degrees in col. 4, lines 35-39. This portion of Ibok, however, describes rounding of the top corners at low temperatures, in particular, about 800 degrees to 900 degrees. Nowhere within this portion of Ibok is it taught or suggested that an angle of the top corners of the trench is controlled according to a contained quantity of hydrogen bromide and chlorine gas in an etching gas as required by Claims 2-6. Thus, for at least the foregoing reasons, neither Huang, Rogers nor Ibok teach or suggest each and every element of Claims 2-6. In view of the foregoing, a *prima facie* case of obviousness may not be established. Applicant respectfully requests reconsideration and withdrawal of the rejection of Claims 2-6 under 35 U.S.C. §103.

In regard to Claim 8, Claim 8 depends from Claims 1 and 7 and incorporates the limitations thereof. Thus, for at least the reasons previously discussed in regard to Claims 1 and 7, Huang, Rogers and Ibok fail to teach or suggest at least the elements of performing an etching process to make top corners of the trench rounded by controlling an angle of the top corners of the trench according to a contained quantity of hydrogen bromide and chlorine gas in an etching gas as founded in Claim 8. Claim 8 further recites the element of wherein the dry oxidation technique is performed at a temperature of about 900°C to about 1000°C to form the lateral oxide layer with a thickness ranging from about 60 Å to about 100 Å. The Examiner admits neither Huang, Rogers or Ibok teach forming the lateral oxide layer with a thickness ranging from about 60 Å to about 100 Å and instead alleges given the teachings of the references, it would have been obvious to determine the optimum thickness, temperature as well as condition of delivery of the layers involved. See Action, page 8. Applicant respectfully disagrees with the Examiner's conclusion for at least the reason that the Examiner has not pointed to a portion of the references expressly teaching use of the dry oxidation technique at a controlled temperature of about 900

degrees C to about 100 degrees C to achieve formation of the lateral oxide layer having a desired thickness. In particular, the portion of Ibok cited by the Examiner, namely col. 2, lines 15 and 16, suggest the use of a temperature suitable for causing rounding of the top corners of the trench, not a particular thickness of the lateral oxide layer. As previously discussed, the Examiner has not pointed to a portion of Huang or Rogers teaching the use of a dry oxidation technique in forming the lateral oxide layer. Accordingly, in as much as the references fail to teach each and every step of Claim 8, it would require more than routine experimentation to develop a method as recited in Claim 8 wherein a dry oxidation technique is performed at a temperature of about 900 degrees C to about 1000 degrees C to form the lateral oxide layer with a thickness ranging from about 60 Å to about 100 Å. Thus, for at least the foregoing reasons, neither Huang, Rogers nor Ibok teach or suggest each and every element of Claim 8. In view of the foregoing, a prima facie case of obviousness may not be established. Applicant respectfully requests reconsideration and withdrawal of the rejection of Claim 8 under 35 U.S.C. §103.

**C.** The Examiner rejects Claim 9 under 35 U.S.C. 103(a) as being unpatentable over Huang and U. S. Patent 6,110,800 issued to Chou (“Chou”). Applicant respectfully traverses the rejection for at least the following reasons.

As an initial matter, the Examiner does not indicate in paragraph 1 of page 9 that Claim 10 is further rejected over Huang in view of Chou, however, on page 11, paragraph 2, the Examiner appears to be relying upon the same combination in rejecting Claim 10. Applicant respectfully requests clarification from the Examiner regarding the rejection to Claim 10. Under the presumption Applicant is correct that Claims 9 and 10 are rejected over Huang and Chou, Applicant traverses the rejection of both Claims 9 and 10 in the foregoing remarks over Huang and Chou in the foregoing remarks.

In regard to Claim 9, for at least the reasons discussed in the traversal of Claim 1 over Huang, Huang fails to teach or suggest at least the elements of forming a trench of which top corners are rounded by etching a surface of a substrate to a predetermined depth by controlling an angle of the top corners of the trench according to a contained quantity of hydrogen bromide and chlorine gas in an etching gas and forming a lateral oxide layer on a partial surface of the

substrate, the partial surface consisting of sidewalls and a bottom area of the trench by oxidating sidewalls of the trench and the bottom area in the trench formed by the etching process as recited in amended Claim 9. The Examiner has not pointed to and Applicant is unable to discern a portion of Chou curing the deficiencies of Huang with respect to at least the element of forming a trench of which top corners are rounded by etching a surface of a substrate to a predetermined depth by controlling an angle of the top corners of the trench according to a contained quantity of hydrogen bromide and chlorine gas in an etching gas and forming a lateral oxide layer by oxidating sidewalls of the trench. Thus, for at least the foregoing reasons, neither Huang nor Chou teach or suggest each and every element of Claim 9. In view of the foregoing, a prima facie case of obviousness may not be established. Applicant respectfully requests reconsideration and withdrawal of the rejection of Claim 9 under 35 U.S.C. §103

In regard to Claim 10, Claim 10 depends from Claim 9 and incorporates the limitations thereof. Thus, for at least the reasons discussed in regard to Claim 9, Claim 10 is not prima facie obvious over Huang in view of Chou. In view of the foregoing, Applicant respectfully requests reconsideration and withdrawal of the rejection of Claim 10 under 35 U.S.C. §103.

**D.** The Examiner rejects Claims 11-20 under 35 U.S.C. 103(a) as being unpatentable over Huang and Chou, and further in view of Ibok.

Claims 11-12 and 15-20 depend from Claim 9 and incorporate the limitations thereof. Thus, for at least the reasons previously discussed in regard to Claim 9, Huang and Chou fail to teach or suggest at least the elements of forming a trench of which top corners are rounded by etching a surface of a substrate to a predetermined depth by controlling an angle of the top corners of the trench according to a contained quantity of hydrogen bromide and chlorine gas in an etching gas as founded in Claims 2-8. The Examiner has not pointed to, and Applicant is unable to discern a portion of Ibok curing the deficiencies of Huang and Chou with respect to at least the element of forming a trench of which top corners are rounded by etching a surface of a substrate to a predetermined depth by controlling an angle of the top corners of the trench according to a contained quantity of hydrogen bromide and chlorine gas in an etching gas and forming a lateral oxide layer by oxidating sidewalls of the trench. Thus, for at least the foregoing

reasons, neither Huang, Chou nor Ibok teach or suggest each and every element of Claims 11-12 and 15-20. In view of the foregoing, a *prima facie* case of obviousness may not be established. Applicant respectfully requests reconsideration and withdrawal of the rejection of Claims 11-12 and 15-20 under 35 U.S.C. §103.

In regard to Claims 13 and 14, these claims depend from Claim 9 and incorporate the limitations thereof. Thus, for at least the reasons previously discussed in regard to Claims 11-12 and 15-20, neither Huang, Chou nor Ibok teach at least the element of forming a trench of which top corners are rounded by etching a surface of a substrate to a predetermined depth by controlling an angle of the top corners of the trench according to a contained quantity of hydrogen bromide and chlorine gas in an etching gas.

Claim 13 further recites the element of wherein the lateral oxide layer is formed at a temperature ranging from about 900°C to about 1000°C with a thickness in a range from about 60 Å to about 100 Å and Claim 14 further recites wherein the screen oxide layer is formed at a temperature ranging from about 850°C to about 1000°C with a thickness in a range from about 50 Å to about 150 Å. The Examiner admits neither Huang, Chou nor Ibok teach the thickness of the lateral oxide layer or screen oxide layer as recited in Claims 13 and 14, respectively. Instead the Examiner alleges given the teachings of the references, it would have been obvious to determine the optimum thickness, temperature as well as condition of delivery of the layers involved. See Action, pages 12-14. As previously discussed in regard to Claim 8, the Examiner has not pointed to a portion of the references teaching the use of a dry oxidation technique at a particular temperature for forming a lateral oxide layer or a screen oxide layer at a desired thickness as is required by Claims 13 and 14 respectively. Accordingly, in as much as the references fail to teach each and every step of Claims 13 and 14, it would require more than routine experimentation to develop a method wherein a dry oxidation technique is performed at a temperature of about 900 degrees C to about 1000 degrees C to form the lateral oxide layer with a thickness ranging from about 60 Å to about 100 Å (Claim 13) and wherein the screen oxide layer is formed at a temperature ranging from about 850°C to about 1000°C with a thickness in a range from about 50 Å to about 150 Å (Claim 14). Thus, for at least the foregoing reasons,

neither Huang, Chou nor Ibok teach or suggest each and every element of Claims 13 and 14. In view of the foregoing, a *prima facie* case of obviousness may not be established. Applicant respectfully requests reconsideration and withdrawal of the rejection of Claims 13 and 14 under 35 U.S.C. §103.

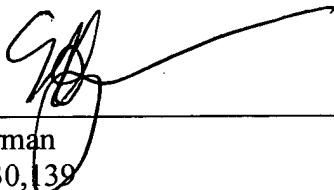
**CONCLUSION**

In view of the foregoing, it is believed that all claims now pending, namely Claims 1-6 and 8-20, are now in condition for allowance and such action is earnestly solicited at the earliest possible date. If there are any additional fees due in connection with the filing of this response, please charge those fees to our Deposit Account No. 02-2666. Questions regarding this matter should be directed to the undersigned at (310) 207-3800.

Respectfully submitted,

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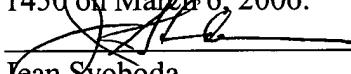
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